INDUSTRIAL HYGIENE SECTION

This Industrial Hygiene Section is published to promote sound thought upon and concerning industrial hygiene. To that end it will contain articles, discussions, news items, reports, digests, and other presentations, together with editorial comments. The editorial policy is to encourage frank discussion. On this basis contributions are invited.

Industrial Medicine

Reg. U. S. Pat. Off.

The Editorial Committee will exercise its best judgment in selecting for publication the material which presents most exactly the factors affecting industrial health and developments for control of potentially injurious exposures. The editors may not concur in opinions expressed by the authors but will endeavor to assure authenticity of fact.

The Science, the Law and the Economics of Industrial Health

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Editor:
WARREN A. COOK

Editorial Committee:
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Editorial Offices:
540 North Michigan Ave., Chicago, Illinois.

Managing Editor:
A. D. CLOUD, Managing Editor, INDUSTRIAL MEDICINE.

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Conservation

—In National Defense—

DESPITE the myriad destructive elements being produced for defense of the nation, the ultimate purpose of these engines of war is conservation of our American way of living. It is accordingly a most logical corollary that, with national defense for conservation, there should be conservation in national defense.

Advanced industrial hygiene methods are going forward in step with defense activities. By the time this goes to press, medical and engineering studies will have been completed in 27 industrial military establishments throughout the country. These include all arsenals of the Ordnance Department, proving grounds and depots. The surveys are being conducted by industrial health teams consisting of trained field personnel of the Division of Industrial Health, National Institute of Health, together with representatives of the Army Medical Corps and the Ordnance Department. With such surveys, information is made available to the Surgeon-General of the Army concerning potential health hazards incident to the wide variety of operations. The extent of the hazards is evaluated and, where necessary, control measures are recommended.

The research staff of the National Institute of Health is available to study the effects of materials concerning which sufficient information may not be available. It is not anticipated that any such catastrophic occurrence will develop as in the last war, when 360 cases of toxic jaundice due to TNT were reported among British munition workers, with 96 deaths, but research is in progress at the National Institute of Health on the toxicology of trinitrotoluene to insure that any unsuspected deleterious effects will be avoided among the many persons exposed to the vapor and dust of this military explosive.

Not only are the military establishments to be included in this survey, but the health hazards in the government-owned, privately-operated defense plants have also been placed under the jurisdiction of the United States Public Health Service at the

request of the War Department. The studies of conditions affecting health in these plants will be undertaken in October as soon as the work in the government-operated plants has been completed.

Of a personnel of 106 persons in the National Division of Industrial Hygiene, 32 professional workers were engaged directly in field activities in the defense industries by early summer. This number has since been augmented and, in order to assure continuity of these services, a quarter of a million dollars has been made available to the National Industrial Hygiene Division in the 1942 fiscal year for surveys of defense industries alone.

The privately-owned and privately-operated plants of the country have by no means been outside the pale of effective industrial hygiene services. State bureaus of industrial hygiene have greatly increased their activities in this field. Private organizations have been extended to keep pace with the demands placed upon them. The Industrial Hygiene Foundation of America has added to its field staff engaged in plant surveys. The Committee on Healthful Working Conditions of the National Association of Manufacturers has held industrial health clinics in manufacturing centers and, in a report of a survey of 2,064 industrial establishments, has demonstrated the manyfold advantages of a health program.* The exhibit of a balance sheet showing, on the basis of actual figures obtained from operating concerns, that a health program saves the average 500-employee plant $5,611 net per year is indeed stimulating. In fact, this amount includes much more than the bare profit element—it incorporates a substantial conservation of material and man power.

The conservation divisions of the insurance companies, the industrial hygiene personnel of individual manufacturing concerns, private consultants, and the training facilities of a number of the universities are all working for the control of health hazards incident to modern industry.

Frantic effort to meet ambitious production schedules tends to sweep all caution before it. But with intelligent management, conservation of resources is recognized as an essential to maximum accomplishment. Most important of the country's resources are its people, and only through the conservation of their health can the maximum in national defense be attained.

*See INDUSTRIAL MEDICINE, September, 1941, pp. 388-397.

Industrial Hygiene Progress

—During the Past Year—

WARREN A. COOK,
President, American Industrial Hygiene Association; Division of Industrial Hygiene and Engineering Research, Zurich General Accident & Liability Insurance Co., Ltd., Chicago, Illinois

INDUSTRIAL hygiene has been a live subject during the past year. With increasing emphasis on national defense, the importance of providing and maintaining healthful working conditions has received wider attention. Meticulous laboratory research and practical field investigation have broadened our knowledge of deleterious environmental factors and have pointed the way to more effective control measures.

Not only do we know how to handle potentially injurious conditions more capably, but it is also of real significance that more work is actually being done in the application of these control measures to industrial conditions throughout the country.

Dust

MOST spectacular of the progress in dust diseases, experimentation with aluminum continues to hold the limelight as a means of prevention and cure of silicosis. In an Arizona metal mine, bombs of aluminum powder are exploded in the headings when the shot is fired to cause admixture of the silica dust with approximately 1% aluminum dust. At another location a group of men who show pulmonary changes caused by silica dust are having their lungs dust daily with aluminum powder. Although it will be months before definite results are obtained, signs are already reported as far from discouraging. Investigators interested in these aluminum dust applications emphasize that its use is not to be recommended as a substitute for dust control.

Although it was early recognized that the 1% aluminum powder-siliceous dust mixture was far below the explosive range, research was reported during the year on the explosibility of silica-aluminum dust mixtures, important in view of the possibility of high local concentrations of aluminum dust. A silica dust percentage twice that of the aluminum dust was found to be sufficient to prevent explosion and, whereas an ounce of aluminum dust would presumably be effective in inhibition of silicosis in an air volume of 8,000 cubic feet, an ounce must be confined to only 25 cubic feet of clean air to be explosive.

Evidence was presented during 1940 indicating that silicosis is still very much with us as an occupational disease. In Ohio, it was reported that in less than the three years of its inclusion in the compensation law, 131 silicosis claims had been approved out of a total of 387 claims filed with 66 still pending. The foundry and the ceramics in-

Presented at the Second Annual Meeting of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION, Pittsburgh, May 8, 1941.

dustries contributed 90% of the claims awarded in that state. Figures released during 1941 continue to show this same trend.

Major rock tunnelling operations were in progress during the year. The dust and gas control measures in force at the New York aqueduct project were followed in drilling the seven tunnels of the Pennsylvania Turnpike. Periodic dust counts were made of tunnel air, as were tests for carbon monoxide after blasting. Methane tests were also made. Wet drilling was used throughout. Pre-employment physical examinations including chest x-rays were made to assure that workers were in good health. At the three rock tunnels on one water-power project in western North Carolina and two tunnels on a second such project in this area, similar precautions were followed. It was not being left to chance in 1940 that everything would be all right. State departments, insurance companies and contractors were being sure that everything was as it should be.

In South Africa, engineering and medical control have caused a new low record for silicosis cases, but there is a marked increase in the incidence rate with longer duration of service and also with more time spent in machine drilling.

Results of the operation of the New York State dust code for rock drilling were reported, together with the distribution of rock of various free silica percentages. Most drilling operations in this state are conducted in rock which averages either less than 10% free silica or appreciably more than this threshold percentage. In the former case, exposures up to 100 million particles per cubic foot of air are considered permissible but where the free silica averages more than 10%, dust control measures must keep the concentration to the more stringent 10 million particles limit. This mineralogical situation has appreciably assisted the administration of the code by reducing the number of difficult borderline cases.

Stone crushing plants have long sent their huge dust clouds into the air to be breathed by the plant operators and to cover the countryside. The effective dust control applied to the large crushed stone aggregate plant in the construction of TVA's Hiwassee Dam project was reported by L. P. Hatch and D. F. Shaw. Structural details of the exhaust ventilation system and results of determination of dust concentrations were given to serve as an excellent guide to other engineers confronted with similar problems.

Roofing granule plants constructed and placed in operation during the year in New Jersey and in Wisconsin incorporated dust control and dust collection. In Utah, a capable and complete study of dust conditions and their effects on the health of workers in bituminous coal mines, non-ferrous metal mines and non-ferrous metal smelters was reported. In North Carolina, similar studies were made of men exposed to mica, kaolin and pegmatite dusts — the latter being made up of mica, quartz and feldspar.

Experimentally, Gardner has increased his evidence that silica particles over 3 microns in size are physiologically insignificant. Tebbins concurred but went even further. On using dust fractions containing particles smaller than 3.3, 1.7, 1.0 and 0.6 microns, he found that particles in the 1.7 and 3.3 micron range caused no gross pathological changes, while the dust in the smaller ranges produces such changes. Miller continued his extensive study of the response of peritoneal tissue to industrial dusts and, with Sayers, reported results of 10 dusts causing absorptive reaction, 13 dusts causing a proliferative reaction and 46 dusts causing an inert reaction. The first and third groups were thus not productive of silicosis whereas dusts in the second group would cause silicosis on sufficient exposure. Every dust producing a proliferative reaction included free silica.

In the experimental study of dust in air, a new constant dust feeding device was devised by Williams and Battista. No striking developments were noted in dust determination procedures, although Williams presented a technique utilizing a blood-counting cell with an unorthodox 300 magnification microscopic system, and Ohleiser published a method using a similar cell but with the usual 100 magnification microscopic system which he and Lawrence had developed some years ago and have been using satisfactorily ever since.

The results of experience with the Bureau of Mines type midget impinger, the electric precipitator and methods of counting are usefully discussed by the American Public Health Association Committee on "Dust Procedures in Air Analysis," of which Bloomfield is Chairman. It was pointed out that the midget impinger, with its lower nozzle velocity of 12,000 feet per minute as against 22,000 feet per minute of the large impinger, is a practical instrument for the sampling of silica and siliceous mineral dusts, but is much less efficient than the large impinger for sampling fumes.

In the determination of quartz in dust, the application of x-ray diffraction methods is becoming more prominent. Berkelhamer has developed methods for preparation of the sample and has done sufficient work with the method to have recognized both its limitations and its advantages. Investigators at Pennsylvania State College have also carried on developmental work with this method. Berkelhamer upset accepted laws on rate of settling of dusts as a result of measurements made possible by the Leitz tyndallometer.

Lead

CONFLICTING conjectures have been advanced concerning the relative toxicity of lead and some of its common compounds. Fairhall has cleared up many of these uncertainties by a comprehensive research on the amount of lead absorbed into the body on exposure to these materials. Experiments were conducted with 500 guinea pigs, some of which ate the lead, others inhaled it, and still others received it through intraperitoneal injection. Lead arsenate, carbonate, monoxide and sulphate were somewhat more toxic than lead and other lead compounds when fed to the animals. On inhalation, lead carbonate

and lead monoxide were definitely more toxic than the other lead compounds. When injected into the peritoneum, lead and its compounds remained without appreciable absorption except for lead arsenate which produced rapid and definite evidences of absorption, due to the solubility of the arsenic portion of the compound. Generally, the lead compounds were found to be much more toxic when inhaled than when ingested or injected.

To obtain further data on effect of ingestion of known amounts of lead, Kehoe fed one human subject 2 milligrams of soluble lead daily for 13 months and a second human subject 1 milligram daily for 39 months. Neither showed any symptoms or blood changes indicative of injury. Lead excretion increased so that only a slight and almost negligible amount of this lead was retained in the body. Of especial interest from an industrial hygiene point of view, concentrations of lead in urine of 50 to 150 gamma and slightly more are compatible with normal health and well being of human adults. Also of interest, it was found through an extensive series of analyses and observations of freely chosen diet, that adults in various parts of the United States ingest with food and beverages from somewhat less than 0.10 milligrams to somewhat more than 2.00 milligrams of lead a day, with a mean value of a third of a milligram a day.

Nineteen Hundred Forty gave further evidence of industry's accomplishments in controlling its health hazards through modern, industrial hygiene methods. Published during the year was the report of the industrial hygiene sessions held at the annual convention of the National Battery Manufacturers' Association. This Association instigated the survey of its lead exposures which was recently made by the National Institute of Health. The report includes a summary of the results of this survey together with discussion of various phases of industrial hygiene in the lead battery industry.

The steel industry did not rest with control of the lead hazard within the steel plant when leaded steels were being produced — it went further and investigated the potential hazards to the users of such steel. Amounts of lead volatilized under such operations as machining, heat treating, forging, oxyacetylene cutting and arc welding were determined by Halley and Martin. Significant amounts of lead are released only when scale is produced or the steel is actually melted. Amounts of air which should be moved for reducing the lead disseminated into the air to safe limits are calculated for these several operations.

The lead exposures in the printing industry were determined by Ruf in a group of 14 Wisconsin plants, and 40 employees of these plants were examined for evidence of lead absorption by Belknap. The study showed that, with few exceptions, atmosphere lead concentrations were within safe limits but it was added that ordinary precautions were not to be considered unnecessary. To avoid dispersion of lead dust into the air, vacuum cleaners were recommended for cleaning type cases and floors. Physical examination and laboratory findings on the workers showed them to be in good health, the only evidence of lead absorption being the somewhat high average urinary lead excretion of 190 gammas per liter. Additional data are being developed on the subject of lead exposures in the printing industry during the present year.

Occupational lead poisoning has occurred during the past year in novel ways, such as the case of the police detective who dusted articles with white lead in searching for finger prints, and the roofers who held galvanized nails in their mouths; also it has occurred through such a well known manner as using an oxyacetylene torch to cut up steel painted with red lead — in this case, a bridge in France which had been blown up.

In the determination of lead in air and in urine, the dithizone method remains in use as the optimum chemical method though the diphenylcarbazide method which it superseded appeared in the 1940 literature for use with biological material. Precipitation in a centrifuge tube at pH 6.6 to 7.4, with separation and washing of the double chromate by centrifuging and final determination without preliminary separation of lead, are features. Polarographic methods are gaining in popularity for rapid determination of small amounts of lead, and methods are being worked out for use of the spectrophotelometer.

Lead has found its way into a number of industries and operations with national defense developments. Defense contracts have specified use of lead chromate as a pigment in departments of automobile plants where non-lead paints have been in almost exclusive use for a number of years. The scarcity of a number of non-ferrous metals is leading to the introduction of alloys containing a high percentage of lead in die castings. Advances in knowledge of lead poisoning control are keeping ahead of such increases in operations involving lead exposures, but it behooves industry and the industrial hygienists to be constantly on the alert to apply these preventive measures before cases of actual poisoning occur.

Solvents

DURING the year, an entirely new group of solvents, the nitroparaffins, were made available in commercial quantities. No recent investigation had been made of their toxicity though it was known that these compounds were irritating and possessed harmful properties. The manufacturers, following what is fortunately a modern tendency, sponsored a thorough study of the toxicology of these compounds, the results of which were reported before the end of the year. This precaution very possibly avoided cases of occupational poisoning with resulting hysteria concerning these useful solvents, inasmuch as they were shown to be toxic. Unlike the paraffin solvents, the nitroparaffins are lethal in concentrations far below those producing narcosis, and beginning narcosis cannot safely be used as a warning of dangerous concentrations. With this knowl-

edge of the effects of nitroparaffins, the valuable group of compounds can find a useful place without jeopardizing the health of the user provided the necessary precautions are observed. Particularly gratifying was the close relation between the two events of release of commercial amounts of these solvents and release of these toxicological data.

Specht and his associates of the U. S. Public Health Service published a bulletin giving experimental results on extended pharmacological studies of 11 ketones. The depression of the various bodily functions was found to be directly proportional to the concentration of the inhaled vapor, to the duration of exposure, and, in the homologous series of straight-chain methyl ketones, to the number of carbon atoms in the chain. The need for study of individual compounds was indicated by the finding that modifications in the molecular structure other than extension of the carbon chain were concomitant with relatively unpredictable narcotic strengths. This work is an indication of the type of integrated investigations which may be expected in the future with the National Institute of Health established in its new quarters.

The U. S. Bureau of Mines has made a start in the publication of its mass of experimental data on benzene. It is hoped that this will be continued and that the Bureau's methanol data can be issued shortly.

Von Oettingen published another of his monumental surveys and interpretations of the literature, this time covering the volatile hydrocarbons. Half of the material is devoted to the aliphatic hydrocarbons, a portion of the field which ordinarily is dismissed much more summarily. Reports of actual cases of poisoning, chronic as well as acute, from such hydrocarbons indicates that serious attention should be given to them, even though appreciably greater exposures can be tolerated without injury than is the case with the aromatic hydrocarbons.

The American Standards Association has made a good start in its program to bring uniformity to the accepted safe limits for vapor concentrations by issuing well-considered figures for benzene and carbon disulphide. The American Standards include properties of the material, the permissible concentration, sampling procedure, analytical methods, bibliography and references for general information. Among the essential elements often omitted from lists of toxic limits is the duration of exposure for which the limiting value is applicable. For benzene, the maximum allowable concentration is given as 100 parts per million parts of air by volume, and for carbon disulphide, 20 parts per million, both for exposures not exceeding a total of eight hours daily.

The increasing realization of the importance of solvent-vapor control throughout all industry has had its effect on the viscose rayon industry. A bulletin on occupational poisoning in this industry was prepared by Alice Hamilton and published by the U. S. Division of Labor Standards. The harmful vapors or gases to which workers in this industry may be exposed are carbon disulphide and hydrogen sulphide. The former is an essential chemical used in the churn rooms to dissolve alkali cellulose and to form cellulose xanthate. In a later step, the xanthate, dissolved in alkali, is forced through dies immersed in an acid bath and thus converted into thread. As the result of the chemical reaction in the bath, some carbon disulphide is again liberated and hydrogen sulphide is formed. In general, concentrations of both carbon disulphide and hydrogen sulphide are easily kept well below the value of 20 parts per million approved by the American Standards Association.

Throughout the industry, it is common practice to ventilate the churn rooms and, better still, to run the churns either under a negative pressure or else to use special churns in which the churn is closed as soon as it receives its charge of alkali cellulose. It remains closed when the xanthation is completed and the xanthate is dissolved in alkali.

In addition to these measures, the American Viscose Corporation has been active in developing a CS_2 recorder which is being shown by Calvert, of the American Viscose Corporation, and McKee, of the Harvard School of Public Health.

It is interesting that two studies on the metabolism of carbon disulfide have followed as a logical sequel to control of the vapor by ventilation devices. Such studies have been reported on other solvents such as alcohol, ether (Haggard), and benzol (Schrenk); and it is to be hoped that they will be made on many other common industrial solvents of interest to industrial hygienists.

Gases

OF THE gases, hydrogen sulfide has had some prominence as discussed above due to its formation in the viscose process. Hydrogen sulfide from the spinning baths has given some trouble in the past and undoubtedly is partly responsible for "sore eyes," a condition which is very rapidly being eliminated throughout the rayon industry. Spinning baths more and more are being enclosed and the process mechanized to such an extent that excellent ventilation is feasible. The American Viscose Corporation cooperated with Philip Drinker of the Harvard School of Public Health in the development of an H_2S recorder utilizing the diethylamine reaction, but recent improvements in ventilation have rendered the need of such a recorder problematical, as it has been the experience of the American Viscose Corporation that concentrations are generally well below 10 PPM. The American Standards Association has set 20 PPM for an eight-hour exposure for this gas.

In addition to the viscose industry, the petroleum industry continues its interest in this gas. The regenerative scrubbing process of vapors before processing in a non-selective polymer plant entailed the handling of hydrogen sulfide in a comparatively pure state. A sampler handling 20 cubic feet of air per minute from 15 different stations was designed and a photo-electric cell type of detector installed to operate an alarm.

The greatest potential exposure to any occupational poison is to carbon monoxide.

The difference between brief and prolonged exposures is taken into consideration by the American Standard released on this gas whereby 100 parts per million is given for the eight-hour exposure and 400 parts per million for exposures not exceeding a total of one hour daily. It is also stipulated that the atmospheric oxygen be not below 19% by volume for the eight hour exposure.

Studies conducted by Heim on the effect of an atmosphere containing 100 parts per million of carbon monoxide at an altitude of 10,000 feet showed that the oxygen-carrying capacity of the hemoglobin was reduced by 10.5%, thereby bringing the blood into a state of anoxemia. The importance of further reducing permissible limits of this gas in airplane compartments operating at reduced atmospheric pressures in high altitudes is thus apparent.

Sulfur dioxide is being used as a diluent of air in magnesium casting to prevent serious oxidation. With production of magnesium castings on the increase, this exposure assumes greater importance.

Hydrogen cyanide has not produced any mass of poisoning cases from the wide use of sodium cyanide metal treating baths found through industry, but a fatal case of poisoning occurred where the molten material spattered on a worker's skin and caused poisoning through absorption of the cyanide.

Ingenious methods sometimes entail unexpected results, as was the case where a nitric acid bath was used as a new method for sharpening old files. At one plant, every worker exposed to the nitrogen oxide gases was injured, one seriously.

Helium-oxygen mixtures have been in use for the alleviation of ear-block among men working under air pressure, and a new apparatus for its administration was devised and published by Brubach, Crisp and Neal, from the National Institute of Health.

Among the gases which are less familiar, decafluorobutane, boiling at 4.5°C. and decafluorocylopentane, boiling at 23°C., were investigated by Plattner, who found that lethal results were produced due to lung irritation.

Dermatitis

THERE was much of importance discovered in the field of occupational dermatoses during the year 1940. Since the field of occupational skin diseases includes such a wide variety of materials, we will refer to only a small number of the outstanding reports on such conditions.

Clothing made of synthetic resins (Pliofilm, Vinylite, and Koroseal) was found to be effective in protecting workers against industrial skin irritants.

An outbreak of dermatitis among the general population was traced to a finish containing a synthetic resin. A method of testing the irritant properties of new fabric finishes before selling them to the public was devised.

An ointment containing an oxidizing chemical such as sodium perborate was found to act as a protective against ivy poisoning.

Occupational leukoderma occurring among workers wearing a certain brand of rubber gloves was found to be caused by an antioxidant, monobenzyl ether of hydroquinone.

Harsh skin cleansers were stressed as causes of industrial dermatitis.

Criteria for the diagnosis of occupational skin disease were formulated by the National Committee of Occupational Dermatoses.

Industries engaged in the defense program were surveyed by Federal and state industrial hygiene units for the purpose of eliminating occupational skin and health hazards.

The first textbook by American authors on occupational diseases of the skin was published.

Abstracts of the literature on occupational and related dermatoses were prepared for publication as U. S. Public Health Bulletin No. 266.

Mercury

FOLLOWING the study of the mercury poisoning hazard in the hatters' fur manufacturing industry, a similar study in the hat manufacturing industry was completed during 1940 by the Connecticut State Department of Health Bureau of Occupational Disease in cooperation with the National Institute of Health. Mercury is present in these plants as a result of the use of a mercury nitrate solution for initial treatment of the rabbit fur of which the felt is made. In addition to the information obtained on exposures in various departments of these plants and the extent of the occupational diseases which resulted, the report provides a real contribution to the knowledge on the subject of mercury poisoning. No cases of poisoning were found among hatters exposed to less than 1.0 milligrams of mercury per 10 cubic meters of air as measured by the Nordlander apparatus.

Stoch continued his researches on mercury poisoning and published results of analyses of mercury content of different human organs.

Welding

ELECTRIC welding has been the subject of much basic investigation during the past year. The results of an epidemiologic and clinical investigation conducted by Drs. Britton and Walsh indicated that among several hundred welders in large plants, no demonstrable injury to health occurred and that the general health of the group was as good as or better than that of the entire working population.

An extensive research on the subject has been carried on by Harrold, Meek and McCord at the Chrysler Industrial Hygiene Laboratories. The significance of this work to National Defense is evident when we appreciate that welders must continue on the job if the many metal products fabricated by welding are to continue to roll off the production lines. These investigators reported that over-emphasis appears to have been placed on

the effects of nitrogen oxide gases, carbon monoxide, ozone and iron fume, the products emanating from the process. They point to the constituents of coatings on rods, coatings on metals, and special constitutents of the metal rod or the metals being welded as possible sources of practical hygienic problems.

Work on the coated welding rod problem was conducted at the Harvard School of Public Health by Tebbins as part of a fellowship project of the Industrial Hygiene Foundation of America, and included a study of the nature and quantity of the fumes and gases liberated during arc welding with coated rods. The General Electric Company contributed equipment and welding experts. This study, too, pointed to the operation as a safe job, provided that the worker observed certain precautions such as avoidance of exposure to ultra-violet light from the arc, provision of ventilation in confined spaces, and limitation of visible fumes to reasonable concentrations.

Similar results were obtained at an investigation conducted at Ohio State University. A preliminary report was released by Case and Castrop, of the General Motors Company, giving results of concentrations of gases and fumes resulting from both electric and acetylene welding.

Ventilation

IN THE field of dust collection, Shepherd and Lapple have presented further data on the performance of cyclones, particularly the effect of the removal of the inlet vane. Hemeon has presented field data on the performance of filter units, and also a general presentation on dust control in the granite industry in Massachusetts.

L. P. Hatch has published a method for designing complete exhaust systems, which makes the engineering approach to a well-balanced system much simpler.

T. Hatch and W. Battista have presented approximate equations for steam-exhaust hood design and also some data on plating-tank ventilation and manifold construction. Silverman, working on an Industrial Hygiene Foundation fellowship, studied the factors affecting hood design for single-slot unheated tanks, such as those used for cold-plating, pickling, acid-dipping, alkali baths, and wash tanks.

The effect of temperature and of solvent characteristics on ventilation requirements, together with the performance of double-slot hoods, is being studied further.

Kravath has published data on the use of the venturi ejector for ventilating paint-spray booths and other types of installation where the direct use of a fan is undesirable. Hemeon has also presented some data on air dilution in ventilation, as applied to both general and local exhaust. In their welding study, Tebbens and Drinker developed information on ventilation requirements showing increases necessary as electrode size increases.

Witheridge and Walworth have given information on the performance of an exhaust system for a degreaser which shows that the conventional horizontal slot method obtains the best results.

T. Hatch has described a low-resistance exhaust system which gives excellent control with a material reduction in power and maintenance cost. Kravath has also shown calculations to emphasize the value of using streamlined fittings and general resistance reduction.

Bacteria in Air

THE field of bacteria in air has been particularly active. Much work has been done on methods of determination, together with results obtained through application of these methods. Among the most active in this field have been DallaValle and Hollaender, together with their associates in the National Institute of Health, and W. F. Wells and his associates.

The effects of ultra-violet radiation and filters on microorganisms suspended in air were studied by this same group. The American Hospital Association released a bulletin on the subject of ultra-violet rays as a sterilization agent in hospitals. Robertson and Doyle published work on the control of air-borne bacteria in operating rooms and hospital wards. Use of ultra-violet radiation in operating rooms was discussed by Kraissel, Cimiotti and Meleney.

Industrial Hygiene Control Agencies

A COMPREHENSIVE discussion of the recent development of industrial hygiene in the United States together with the activities of official and non-official agencies is included in a report released in 1940 entitled "A Preliminary Survey of the Industrial Hygiene Problem in the United States" prepared by Bloomfield and his associates in the National Institute of Health.

Control of Tuberculosis

—Opportunities in the Industrial Health Program—

THEODORE HATCH,
Associate Professor of Industrial Hygiene, Department of Public Health and Preventive Medicine, University of Pennsylvania School of Medicine

TUBERCULOSIS is of especial interest to the industrial hygienist for two reasons. First, because of its essential relation to silicosis, it is a specific occupational disease of those industries which involve an exposure to silica dust. Second, while simple tuberculosis is a disease of the general population, it occurs more frequently among the workers in certain industries than it does among the population as a whole. This does not mean that the industrial environment predisposes to tuberculosis, since the workers' families are also adversely affected. The modern industrial health program, however, con-

Read before the Pennsylvania Tuberculosis Society, Erie, Pennsylvania, April 16, 1941.

cerns itself with the general health of the worker as well as with specific occupational hazards, and tuberculosis must therefore receive consideration beyond its limited significance as an occupational disease. Some aspects of the tuberculosis control program in industry are discussed in the present paper.

Tuberculosis as a Specific Occupational Disease

TUBERCULOSIS has long been recognized as a specific occupational disease of those industries in which the workmen are exposed to silica dust, the etiological importance of which has been clearly demonstrated by studies in this and other countries. The curves in Fig. 1 are sufficient to

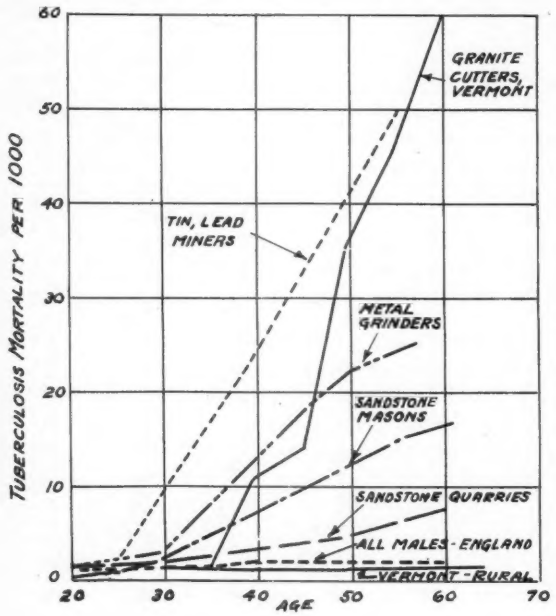

Fig. 1.
Effect of silicosis upon tuberculosis mortality in certain industries.

show how serious the problem has been. In the typical silica industries, without adequate control, tuberculosis is found to be not only excessive but under conditions of extreme dust exposure becomes the predominant cause of death.

It is estimated that more than 1,000,000 industrial workers in the United States are exposed in varying degrees to silica dust. Chief among the industries involved are: Metal-ore and anthracite coal mining; granite quarrying and miscellaneous rock excavating work; manufacture of pottery, glass, and other ceramic products; stone crushing, screening, etc., and foundry operations to some extent. In addition, there are isolated exposures to silica dust in a great variety of industries. Silicosis has even been reported among dental laboratory workers! Thus, the potential silicosis hazard is widespread and the problem it presents is an important one, not only to industry, but also in its relation to the whole tuberculosis control program. Lanza and Vane[1] have called attention to the part which silicosis may play in determining the excessive tuberculosis mortality among industrial workers as compared with the general population.

Effective measures for the control of silicosis have been developed and are being applied successfully in a number of industries. These include both engineering and medical procedures. The latter should be emphasized because of the seriousness of tuberculosis in silicotics. Uncomplicated silicosis is said not to be disabling. Every effort must be made to keep infected persons away from silica dust because of the great personal risk and also because the presence of such individuals greatly increases the hazard to other workers. Pre-employment examinations are required so as to eliminate at the outset all tuberculous workers and others with respiratory infection or evidence of low lung resistance. Periodic examinations thereafter of all exposed workers are also required in order to discover at the earliest possible moment the development of silicosis, and more particularly tuberculosis, among them. In this connection, mention should be made of the danger of spread of infection in the homes of workers suffering from silico-tuberculosis. Early studies of silicosis emphasized the comparatively low tuberculosis mortality among the families of its victims and, as a result, the belief arose that tuberculosis in silicotics was essentially non-infective. With further study this view has been altered somewhat. The organism recovered from the sputum of silicotics is virulent when injected into test animals and it must, therefore, be regarded as infective. The relative freedom of the family from tuberculosis, may be accounted for in part by the fact that tuberculosis superimposed on silicosis generally develops at a late age, after the children have left home.[1] It also progresses to the terminal stage more rapidly than does simple tuberculosis, and the period of exposure of other members of the family is therefore relatively much shorter. It is obvious that these fortuitous advantages cannot safely be relied upon wholly to prevent the spread of infection.

Non-Industrial Tuberculosis and Occupation

THE higher tuberculosis mortality among certain groups of industrial workers, as compared with the general population, has been mentioned. This is accounted for, in the silica industries, by the essential relation between silicosis and tuberculosis. No similar relationship however with other substances encountered in industry has been demonstrated. It has also been pointed out that the greater incidence of the disease is not limited to the workers but is also observed among their families. This suggests that it is the domestic rather than industrial environment which produces the unfavorable experience. Such domestic factors as over-crowding and malnutrition and others which may be measured in terms of economic status, are known adversely to affect the tuberculosis mortality. A partial test of the relative importance of the domestic and

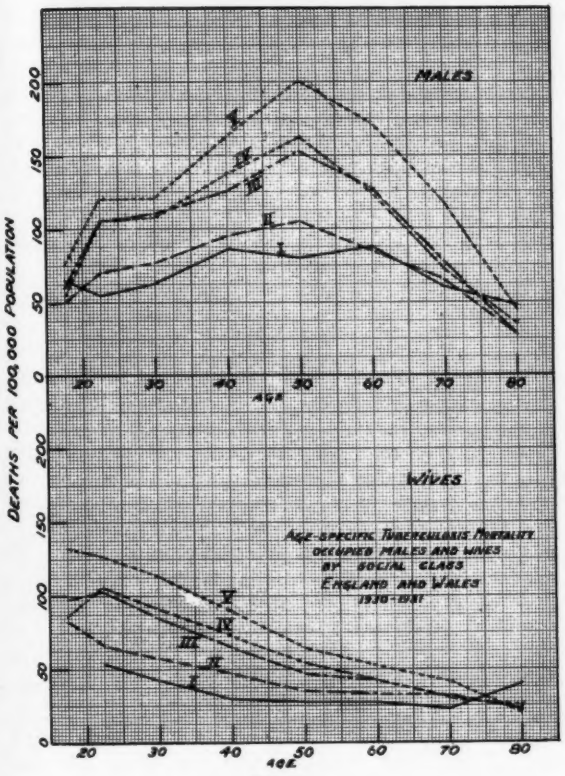
MALES
WIVES
AGE-SPECIFIC TUBERCULOSIS MORTALITY OCCUPIED MALES AND WIVES BY SOCIAL CLASS ENGLAND AND WALES 1930-1931
DEATHS PER 100,000 POPULATION
AGE

Fig. 2.
Age-specific tuberculosis mortality for occupied males and their wives, by economic class, England and Wales, 1930-31.

industrial environments may be made by comparing the tuberculosis mortality of industrial workers in various occupation groups in relation to all males, with that of their wives relative to all women. If industry itself has an adverse effect with respect to tuberculosis one would expect it to be reflected in a higher standard mortality ratio for the occupied men than for their wives who are employed in industry to a much less extent but who are subject to the same economic limitations and domestic environment. In the following graphs, this test has been applied to the mortality data for various occupations and economic classes in England and Wales for the year 1930-31.* In Fig. 2, the age-specific death rates from tuberculosis are shown for occupied men and their wives in five industrial classes.** It will be observed that for both men and women the mortality increases with decreasing economic status. The age-distribution curves retain the same characteristic shape in all five classes with the maximum mortality rate at age 50 for the men and around age 20 for the women. In order to draw any conclusion from these data, it is necessary to convert them to a common basis for comparison. This is done for the five groups in Fig. 3, using the standard mortality ratio*** as the parameter. Except in Classes I and V, the ratios for the men and women are alike. In Class I, the highest economic group, the women have a slight advantage whereas in Class V, the men had relatively less tuberculosis.

These findings indicate that the industrial environment, generally, does not play a direct part in determining the tuberculosis mortality among occupied males. Further indications of this are found in a study of the various occupations which make up the five economic groups. Within most of these groups no statistically significant differences between the ratios for husbands and wives were found. Those which did differ significantly are shown in Fig. 4, and in the majority of them the relative mortality for the wives was higher than for the occupied men. Exceptions include such occupations as hairdressers and innkeepers, in which physical selection for the job plays a part, and others which involve exposure to silica dust such as masons. In a more elaborate statistical analysis of the problem, Collis and Greenwood[2] reached the same conclusion concerning the influence of the industrial environment upon

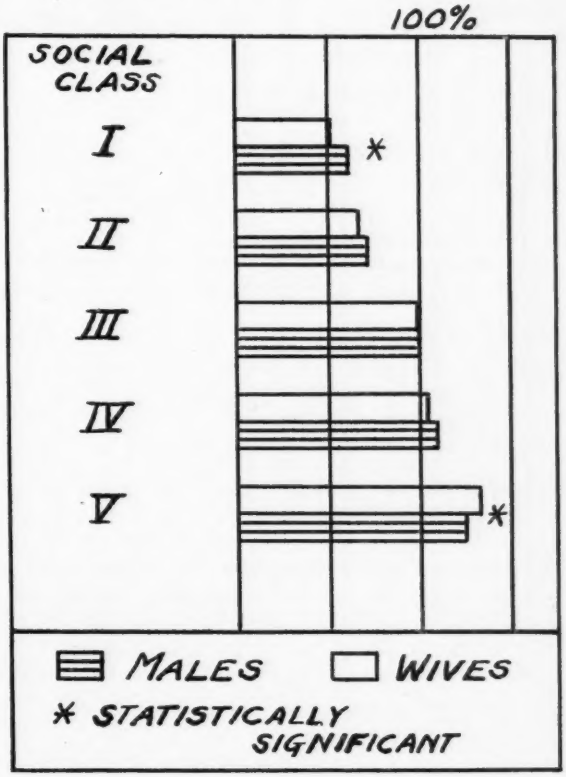

Fig. 3.
Standard tuberculosis mortality ratios for occupied males and their wives, by economic class. England and Wales, 1930-31. Note that in each class the ratios do not differ markedly.

*I am indebted to MISS ELIZABETH H. PITNEY, Research Secretary, Philadelphia Health Council and Tuberculosis Committee, for the analyses of these data. British data were employed since U. S. records are not available in the desired form.

**The five groups are divided approximately, as follows:
Class I: Professional
Class II: Semi-professional
Class III: Skilled workers
Class IV: Semi-skilled workers
Class V: Unskilled workers

***The standard mortality ratio is the ratio (expressed as a percentage) of the mortality for a particular group to the mortality for the entire population under study, both adjusted to the same age distribution. Equal standard mortality ratios for husbands and wives in a particular group means that the difference in their death rates is the same as the difference among all men and all women.

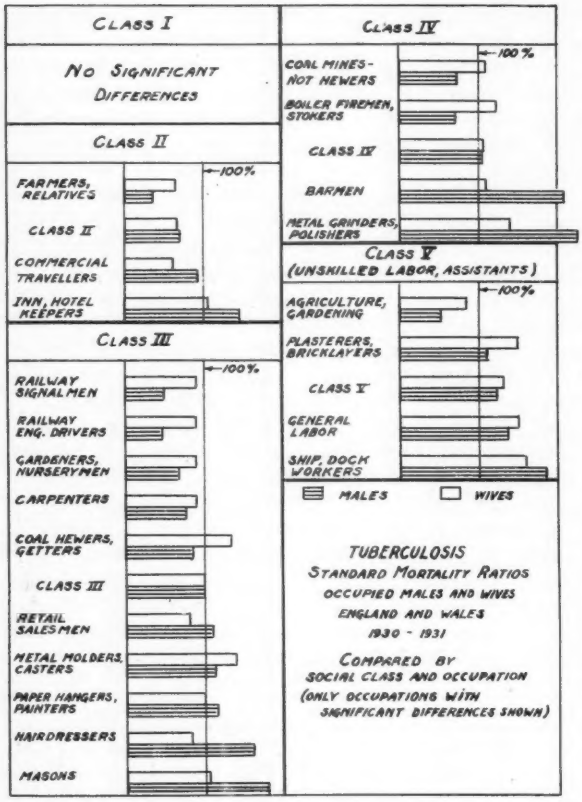

Fig. 4.

Standard tuberculosis mortality ratios for occupied males and their wives, by occupation, England and Wales, 1930-31. Note that in the greater number of cases, the mortality ratio is higher for the women. Exceptions include masons and metal grinders, and certain occupations which do not require rugged individuals.

tuberculosis mortality. It is of interest to note, however, that they found, by the method of partial correlation, a greater sensitivity among the men to the unsatisfactory home environment than among women, and attributed this to the lowered resistance resulting from the wear and tear of industry. More recently, Hart[3] has called attention to the relation between the *retardation* of the decline in tuberculosis mortality among young women since 1900 and the increase in the percentage of women employed in industry, which suggests that competitive industrial life is less favorable than the sheltered home environment of previous generations. This, however, is not necessarily an indictment of the physical environment in industry since there are important psychic factors involved as well.

Tuberculosis Case Finding in Industry

IN THE modern tuberculosis control program, great emphasis is placed upon the early discovery and isolation of active cases of the disease in order to reduce to a minimum the opportunity for contact between infected and susceptible persons. This involves a program of mass case finding, which, for most effective results, should be conducted among those groups in the general population in which the greatest number of cases is likely to be found. This criterion cannot always be met because of the administrative difficulty and expense involved in reaching the most important groups. Since the schools provide convenient aggregations of individuals for mass examinations much effective work has been done in this group despite the fact that neither the mortality nor the incidence of the disease is highest among youths of school age. Expansion of the medical program in modern industry, with its routine physical examination of thousands of workers, offers an unparalleled opportunity for tuberculosis case finding. Is there an advantage, statistically, in mass survey work among this group, as compared with other age groups?

At the present time the tuberculosis mortality rate is highest for males at age 55. This does not mean, however, that the relative risk of contracting the disease is also the highest at this age. Frost[4] showed, on the contrary, that the high death rate in late life today is the result of a much higher relative risk at earlier ages. Tracing the experience in Massachusetts of "cohorts," i.e., groups born in successive decades from 1870 to 1910, he found that the relative risk of contracting tuberculosis at different ages has maintained a substantially constant relation to the mortality during the first decade of life despite the tremendous reduction in the death rate for all ages since 1870. Assigning a value of 1.0 to the mor-

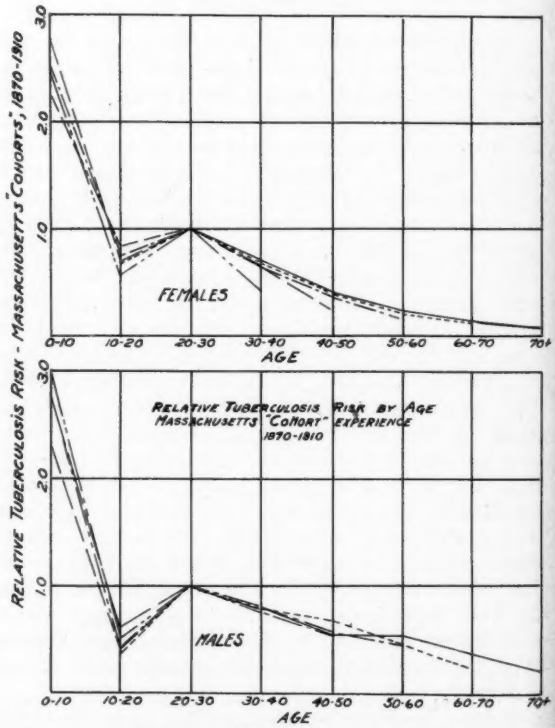

Fig. 5.

Relative risk of dying from tuberculosis, by age. Massachusetts, 1870 to 1910. The "risk" has remained substantially constant despite the tremendous decrease in tuberculosis mortality.

tality at age 25, the relative risk at other ages for successive cohorts since 1870-80 has been calculated with the results shown in Fig. 5. The curves of relative risk thus obtained exhibit approximately equal maximum values in early childhood followed by a marked drop up to the beginning of adolescence after which they rise to reach a second maximum at age 25. Beyond this peak the risk decreases gradually with advancing age.

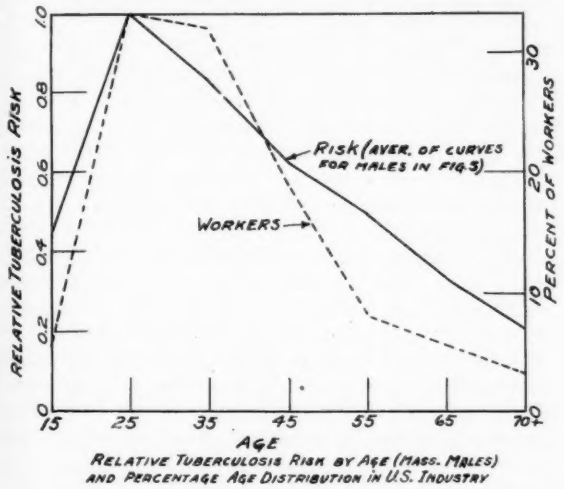
RELATIVE TUBERCULOSIS RISK
PERCENT OF WORKERS
RISK (AVER. OF CURVES FOR MALES IN FIG 5)
WORKERS
AGE
RELATIVE TUBERCULOSIS RISK BY AGE (MASS. MALES) AND PERCENTAGE AGE DISTRIBUTION IN U.S. INDUSTRY

Fig. 6.
Relative tuberculosis risk by age (Mass. males) in relation to the age distribution of industrial workers. The period of greatest risk occurs in the age-group having the greatest number of industrial workers.

The similarity of the curves shows that the relative risk of dying from tuberculosis at different ages has remained substantially constant despite the tremendous drop in the mortality rate since 1870. Downes[5] has called attention to the fact that the relative *incidence* of tuberculosis at different ages has a similar shape with the two maxima occurring within the same age periods. These observations are highly significant since they indicate clearly the salient points of attack against tuberculosis, namely, in early childhood and in the period centering around age 25. This is of particular interest in the present discussion because of the fact that the majority of industrial workers fall within the age-group of maximum tuberculosis risk, as shown in Fig. 6. The close parallel between the two curves suggests at once that for effective tuberculosis case finding beyond childhood, mass survey work in industry offers unusual opportunities. Not only are adults in the vital age group brought together in large aggregations, but, under the modern industrial health program, they can be reached more easily than any other adult group, with the exception of those in the armed forces. Thus, the work of the industrial medical department assumes great importance in the national tuberculosis control program. It must be pointed out, however, that industrial medical services are not yet widespread. No more than one-third of the workers have the benefit of physical examination and the other medical attention which industry can provide. The opportunities for tuberculosis control in industry furnish a strong argument, among others, for the extension of such services.

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Controlled Radium Hazards

PROFESSOR FREDERICK B. FLINN,
Delamar Institute of Public Health, Columbia University

I AM confining myself in this paper to the preventive measures which have been developed in the luminous dial painting industry. With World War II demands, the number of persons engaged in this industry has increased very rapidly. One plant which I know of is now employing between 200 to 300 persons as compared with 35 to 40 employees before the war started.

Radioactive luminous compounds are known under different names. This term includes "radioactive luminous compound," luminous material or "radium paint," all of which refer to a mixture of phosphorescent zinc sulfide and radium, mesothorium or any other radioactive substance.

During World War I the industry employed a number of workers among whom cases of radium poisoning developed in the early twenties. Radium poisoning in this sense was used to distinguish the damage caused by deposition of radium in the body, as against damage caused entirely by external radiation. Radium poisoning was unrecognized in medical history until cases appearing among dial painters were diagnosed by Martland as resulting from ingested radioactive material. As is commonly known it was the habit of the painter to point the brush between the lips and in this way particles of the paint were taken into the mouth and swallowed.

About 1924 I was asked to assist Dr. Gilman Thompson who was engaged by one of the insurance companies to study the luminous paint industry and to determine the hazards existing at that time. As soon as the first cases appeared the habit of pointing the brush between the lips ceased. An investigation of the industry revealed

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certain important information and indicated what steps were necessary to safeguard the health of the worker. From time to time new preventive measures are being developed as suggested by observations of the work.

A review of the industry revealed that previous to 1924 the employee was not given a pre-employment medical examination nor was she given an examination while she was employed. A frail girl or one with some physical defect was often given preference because it was felt that this was the kind of work she could do without overtiring herself. No information was given the new employee as to the hazard of the work for the simple reason that the heads of the company had no conception that it was a dangerous occupation. Patients in Europe and to some extent in this country had been receiving injections of radium salts and no deaths had been reported following such therapeutic treatment. In fact ampules of radium chloride were on the list of new and non-official remedies of the American Medical Association. Signs were placed in the work rooms forbidding the pointing of the brush between the lips but this regulation was not enforced. In my studies I soon found that the girl who was engaged in teaching the workers in the different plants told them, "You are not supposed to put the brush to your mouth but you can make more money that way."

The salary at that time was on a piece-work basis. One cannot blame the young lady because she did not know of the danger herself.

The girls worked at benches close to each other in many of the plants, and there was no ventilation other than that provided by windows. The work benches were of wood and spilled material could not be removed. A visit to the rooms at night showed them to be luminous from the careless handling of the material during the work period. The girls got paint on their hands when mixing the dry material with the adhesive or in other operations. If taken into a dark room luminous material could be seen on the body and the hair. I have been informed by other members of the family that grains of the material would drop out of the girl's clothing when she disrobed at night. Often a girl would paint a design on her forehead or arms when going to a dance. On Hallowe'en some of them even painted their teeth. In general one can say that both the personal hygiene and the plant housekeeping were on a low level.

In some of the plants the workers were crowded into too small a room and the amount of emanations which built up during the working period was higher than should have been.

To an industrial hygienist there was no difficulty in knowing where to begin to improve working conditions.

THE recognized hazards in the work can be classified in order of importance as follows:

1. Ingestion or inhalation of solid radioactive luminous compound;

2. Inhalation of radon liberated from compound into the air, and

3. Exposure of whole body to gamma radiation from compound.

The chance inhalation of the dust is rather small as compared with the chance ingestion of the paint. The particle size is such that practically none will pass a 350-mesh screen. The danger of inhalation rests mainly in the repair work where the paint is removed from the surface by scraping with a sharp knife or similar instrument, or in mixing the paint with the adhesive, when the near-sighted worker may hold her head very close to the mixing crucible. From the time it is mixed with the adhesive the luminous material is wet and there is no danger that it will rise into the air.

The damage done by inhaling the emanation is still on a theoretical basis and depends for its warning signals from the experience in the mines of Schneeberg and Joachinthal. It is well recognized that high concentrations of emanation are dangerous and will cause death. The picture of such an exposure is one of profound anemia and the skeletal destruction seen in the dial painter's picture is not present. I have seen histological sections in the laboratories of Madame Curie that showed a nephritic condition when polonium was present—one of the decay products of emanation. If any pathologic effects are found in the dial painter we would expect them to appear along the line of lung cancer. Although I have been watching some of these girls for 16 years I have not found any suspicion of lung cancer. However it is a matter of great importance, or it is an important precautionary measure to keep the emanations in the air at a minimum.

Nor have we as yet found any damage from the gamma radiation which is present in the work room. But here again it may be a matter of time, and the amount of radiation that the whole body of the employee is exposed to must be kept at a minimum. Our experience has indicated that the first sign of an over exposure to emanation and gamma ray is a change in the blood picture, especially a drop in the white cells. If the condition in the plant is remedied, the blood picture returns quickly to normal. It is because of these findings that the blood picture is important in this industry.

THE first precautions introduced into the industry were a periodic examination of the worker, the enforcement of better personal hygiene and an improvement in the general housekeeping of the plant. These measures have been responsible for the improvement in the health of the worker. Since the practice of pointing the brush between the lips has ceased, I have not found any employee who has shown radioactivty.

When a person applies for employment she is given a physical examination. This examination includes the usual heart, lung and nervous reactions as well as urine and blood tests. No applicant who is not in good condition or who shows a previous history of anemia or tuberculosis is em-

ployed. Menstrual irregularity and history of any disease of the skeleton indicate that the girl should not be engaged in this work. The prospective employees are instructed that their teeth must be put in good condition within a short time after they have been taken into the shop. In addition it is important that only workers who are naturally neat and careful should be employed. Continued carelessness or untidiness in handling the material during the training period is a reason for dismissal.

When a worker is accepted she is informed in detail of all the hazards involved. She is instructed as to the rules and regulations which have been set up for her protection and is informed that if she violates them it will mean her dismissal. In the future a handbook, which has just been published by the Bureau of Standards,[1] containing the recommendations which have been drawn up by a committee for this purpose, will be given each employee.

Each worker is examined once a year or preferably every six months. A physical examination is made as well as a blood study and a radioactive measurement of the radon content of the expired air. It is recommended that the radon test be used rather than the electroscopic or Geiger counter examination. If the expired air should indicate that the employee has more than 0.1 microgram of radium deposited in the body, she is taken off the work and an investigation is made at once to determine what conditions exist in the working area that may have caused the worker to become radioactive. It is believed that if no more than 0.10 of a microgram of radium is present in the body no serious harm will result. However if its presence is discovered at an early period it may be eliminated by decalcifying treatment. This is only possible when radioactive material is in the trabeculae of the bone. Once it is deposited in the cortex of the bone it is impossible to get rid of it and bone destruction will occur. Even if bone regeneration should take place it is only a temporary condition for the process of bone destruction will continue—anyone else to the contrary.

The blood tests which are made at regular intervals very seldom show any clinical symptoms unless a case is involved in which radium poisoning has existed for some time. The most important part of the examination is the determination of radioactivity, but the blood picture is important because it will indicate an over exposure to gamma rays or radon.

The hands, hair and working costumes of the personnel are examined daily by means of an argon or ultra-violet lamp in a dark room for traces of luminous material. If any is detected it is removed with a little of the adhesive. Recently a nurse was engaged by one of the companies to examine the girls for any indication of carelessness in observance of precautionary regulations. This inspection includes:

(a) An examination under the lamp to detect the presence of luminous material.

(b) Inspection of the bench at which the girl is working to see that no candy or gum is kept there. It is against the rules to have anything on the bench except the instruments and material used in the painting operation.

(c) Inspection of the drawer of the work table to see that it contains nothing but the pocketbook and towel.

(d) Similar careful inspection of the lunch and rest rooms is made in order that they may be kept free of luminous material.

The finished work is removed from the work bench frequently and is placed in drying cabinets with exhaust systems. These cabinets are located away from the area occupied by the workers. The stock material is stored in a safe with a one-inch lining, and placed far from the room in which the painting takes place.

Girls engaged in weighing out radioactive material into gram bottles do so under a hood with a good exhaust system and wear a respirator which has been approved by the United States Bureau of Mines.

Applied radioactive luminous compound is frequently removed in repair work preparatory to repainting. The luminous compound must be removed by scraping under liquid. If this liquid is an organic solvent, gloves resistant to the solvent must be provided and must work. This compound contains all of the original radium and is just as dangerous to handle as the fresh compound. Any operation of this kind that must be done in the dry state should be carried on under a hood with forced ventilation to the outside air, and the operator must wear a respirator approved by the U. S. Bureau of Mines.

Working Room

IN order to promote good housekeeping, working conditions have been arranged so as to provide a generally safe environment for the workers, and to encourage their cooperation in carrying out the rules intended to preclude any possible known hazard. The working room is so ventilated that the amount of radon in the atmosphere is kept at a minimum. It is not allowed to reach a concentration higher than 10^{-11} curies per cubic liter of air.

If any higher content is shown, the plant is carefully examined by means of a Geiger-Muller counter to determine where any radioactive material may have accumulated. It is for this reason, and also because it has been found desirable not to expose the entire body of the worker to more than 0.1 roentgen per working day, that finished work is not permitted to accumulate at the tables, but is kept in drying racks with proper ventilation.

To further assure these conditions, special attention has been paid to the floors and working tables. Wooden floors with their inevitable cracks furnish a place for the accumulation of any spilled luminous material. Therefore, a smooth continuous surface such as painted concrete or linoleum has been provided. The rooms are cleaned each day by wet mopping to avoid throwing dry dust

into the air. The tables at which the painters work are so spaced that each has at least 12 square feet of floor space. This prevents over-crowding and at the same time reduces the exposure to gamma rays.

The tables used for dial painting, weighing and other manipulation of luminous compound also have a glazed porcelain or other smooth continuous surface, impervious to moisture and solvents used with the adhesive. While they are, perhaps, not necessary, the company whose employees we have examined for radioactivity, has found that hoods connected with each table apparently furnish additional protection to the worker. These are glass hoods with an air movement of from 20 to 40 cubic feet per minute. Before and after each working period the revolution of the air pump is increased three or four times to assure the complete removal of any emanations that may have gathered. It is my opinion that the advantage of the hoods lies in the fact that any accumulation of active deposits can be removed more readily from the hoods than from walls and ceilings, where material may settle if painting is done on an open table. That it is a good system is indicated by the fact that when the premises were examined by officials, the air of the room was found to be satisfactory and there was no dust in the atmosphere where the girl came in contact with it. Furthermore, a Geiger count gave no indication of an accumulation of active deposit in the air ducts.

Each individual is provided with a porcelain crucible set in a lead block so that her fingers do not come in contact with the luminous compound while mixing the paint with the adhesive. The worker is given only one gram of paint at a time except in very special work. Bottles containing more than one gram of material are set in a lead block to cut down the increased amount of radiation which would be present. The tops of the tables are lined with lead. It is questionable if enough gamma rays could go through the top of the table and strike the limbs of the painter, but it has a psychological effect and serves to impress on the employee that she is working with a dangerous material. A rack is furnished to hold the brush when it is not in use. Sheets of paper are at hand for cleaning the brush or for wiping up any spilled material. The paper is used only once and then thrown into a container. The containers are removed once a day, the papers burned, and the material recovered.

The girls wear smocks which are laundered at the expense of the company each week. These are used only during the working period and are left in the lockers located in the dressing room at the end of each day.

The credit for these improvements is due to the careful study by the companies engaged in this industry.

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Variation of Bacterial Population

—*In Certain Ventilating Systems*—

ALEXANDER HOLLAENDER,
Division of Industrial Hygiene,
National Institute of Health

THE use of artificial ventilating systems has produced a number of problems in connection with the distribution of bacteria in offices, laboratories, and workrooms. The problems which will be discussed here are:

First, are bacteria which are released in certain rooms in a building with recirculation distributed readily all over the building?

Second, how does the bacterial population vary in a building with artificial ventilation in the course of a year?

Third, what are some of the factors which influence the size of the bacterial population?

The investigation to be described was carried out in the Industrial Hygiene Building of the National Institute of Health in Bethesda. This building is located on a fairly high plateau on a 70-acre tract, partly wooded and partly in lawn. Roads on this reservation are tarred. There are no stables in the neighborhood of this building. Laboratory animals are kept in certain rooms with separate ventilation systems. The building has a capacity of 363,750 cubic feet. It has one office floor, two laboratory floors, and two basements, used as laboratories and workshops. The attic is not connected with the general ventilating system. The air intake is in the sub-basement and the air is filtered through a moving oil filter with an efficiency of about 40 to 50% for the removal of bacteria. The air is pre-heated before entering the filter system and humidified after passing through the filter.

In the early part of this investigation up to 60% of the air was recirculated. During 1940 air was recirculated only if the outside temperature came down below 20°F. About seven air changes took place per hour.

Approximately 70 people occupy this building, with about 30 people working on the first floor. The rest of the workers are about evenly distributed on the remaining floors.

Two methods of sampling were used. Most determinations were made with the funnel sampler (Fig. 1). This device, of simple construction, lets measured quantities of air impinge through a funnel on a standard agar plate. Typical results obtained after these plates were incubated for 48 hours are given in Fig. 2. Occasionally the Wells centrifuge was used simultaneously with the funnel device. The results obtained with the two devices checked fairly closely. Both devices showed a large variation in individual samples taken. Most of the samples were taken on standard meat agar, incubated for 48 hours at 30°C

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and 24 hours at 37°C. Occasionally potato dextrose agar plates were used for the detection of fungi. All colonies were counted independent of whether they were bacterial or fungous colonies. The types of organisms obtained during the last few months were analyzed by Mr. Schneiter, bacteriologist in this laboratory. In general, most organisms obtained were of the saprophytic type; occasionally staphylococci were found. However, since only one medium was used for obtaining these bacteria, it may very well be possible that pathogenic organisms of the streptococcus type were missed in our sampling. Three single samples were taken in each room. Sampling time usually was five minutes per sample, five cubic feet per sample. Three rooms were tested on each floor with the exception of the first floor (office) where six were sampled. All samples were taken at about table level. A total of 22 sampling stations were used.

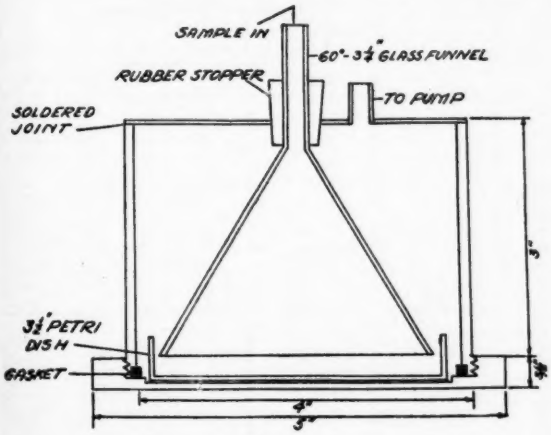

Fig. 1.
Funnel device used for sampling air-borne bacteria.

To test the efficiency of this ventilating system for the transmission of bacteria, the following experiments were conducted. Bacteria was spread into the recirculation intake on the first floor and simultaneous samples were taken in the plenum as well as in rooms on the first and second floors, before, during, and for two hours after spraying of the organisms. To be able to recognize the organisms sprayed into the ventilating system, we used *B. subtilis* spores which form colonies on meat agar easily distinguishable from other types of bacterial organisms. Fig. 3 shows the change of bacterial population on these different floors. The bacterial population was very low before spraying of these organisms. A few minutes after the bacteria were sprayed into the ventilating system, the population in the different rooms had increased many-fold. After the spraying of the bacteria was discontinued, the level of the bacterial population stayed fairly high for another half an hour and then slowly decreased to its former low level. This decrease may be attributed to the dilution factor, to the action of the filter, loss to surfaces such as walls, floors, and the like. It would be worthwhile to investigate the disappearance of bacteria as influenced by humidity, temperature, and other factors.

It should be kept in mind that these data have been obtained with *B. subtilis* spores, an extremely resistant organism which will stand adverse humidity conditions. Many vegetative forms of bacteria probably would not be transmitted by the ventilating system as readily.

I will now describe typical results obtained in the monthly survey conducted for the last two years. First of these spot diagrams (Fig. 4) shows the variation of bacterial population in a laboratory room on the third floor. During the first months of 1939, up to about August, workmen were still installing equipment in this room. During the time from October, 1939, to December, 1939, this room was used on and off as a storage room. During the first part of 1939 hardly any worker entered this laboratory. In August, 1940,

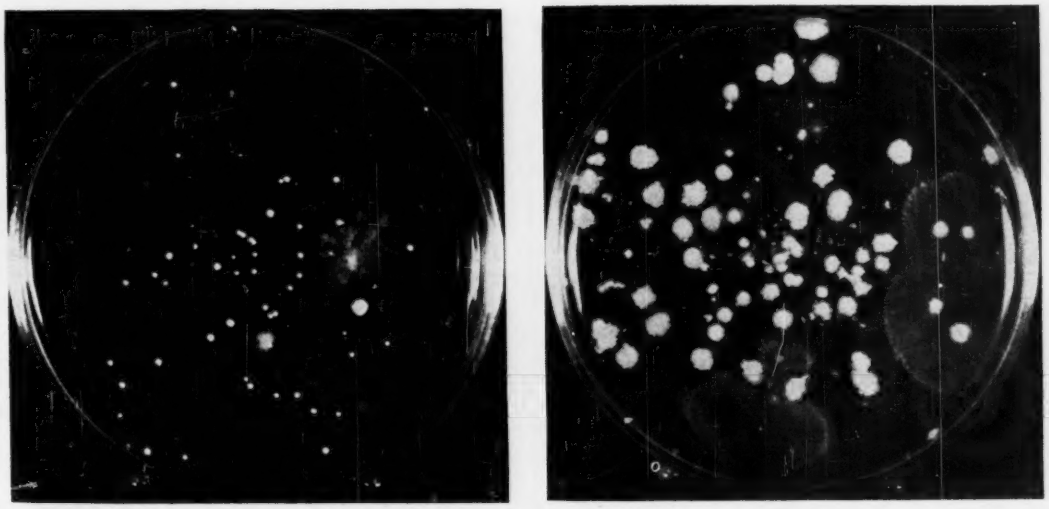

Fig. 2.
Petri dish cultures obtained with funnel device. (Left) sample obtained before spraying of bacteria. (Right) sample obtained after spraying of B. subtilis spores (notice diffuse colonies of B. subtilis).

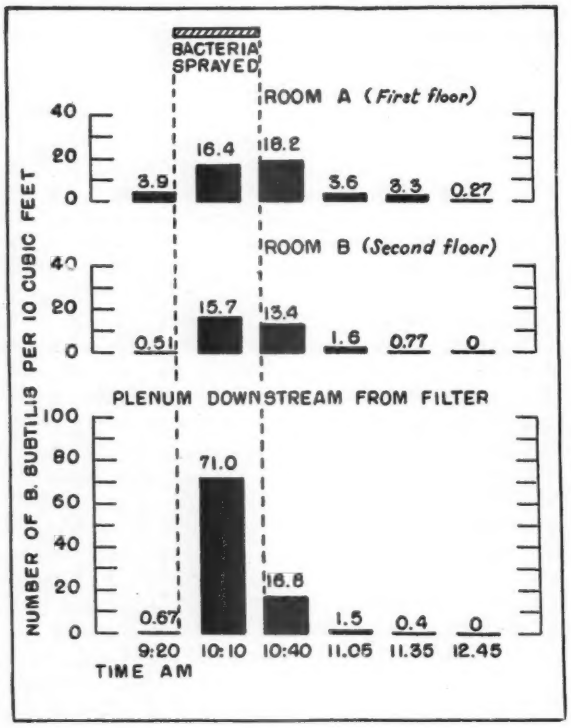

Fig. 3.
Number of B. subtilis colonies per 10 cubic feet of air from samples taken simultaneously on different floors. Bacteria spread into outside air intake between 9:30 and 10:40 A.M.

this room was inspected by a group of workers who in September occupied this laboratory. As soon as activity started in this room, the bacterial population increased five or six-fold. Later on, after the installation of new equipment was completed, the bacterial population came down to a lower level, but never returned to the level it had taken when the room was not occupied.

The next figure (Fig. 5) shows the bacterial population for two years on our office floor which has the largest number of occupants of any floor in the building. During the first months of 1939, old records, office equipment, etc., were moved in. By June and July the staff and equipment for

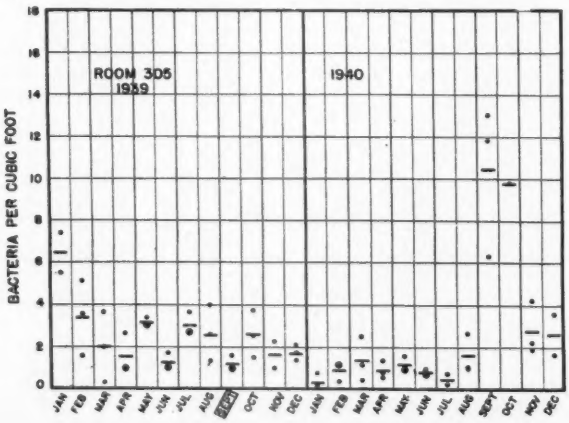

Fig. 4.

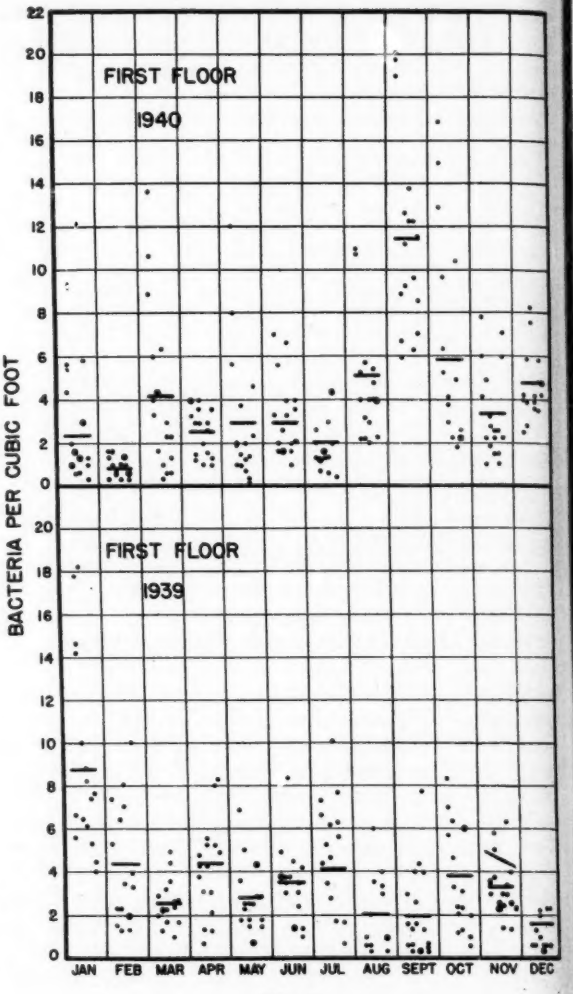

Fig. 5.

the laboratory floors moved into this building, increasing the number of bacteria in the system. Usually during the fall months, October and November, the bacterial population increases on most floors. This is partly caused by the large number of bacterial and fungous spores in the outside atmosphere during these months. In general, when the ventilating system begins to distribute air in the building, some dust which collected in the vents and the outlets is blown into the rooms. Further, the air currents produced by air coming from the ventilating system probably disturbs settled dust in different localities. The bacterial population in September, 1940, increased many-fold. This was caused by the fact that a number of sheep and goats, used for experimental purposes, were kept near the air intake of the ventilating system. After these animals were removed, the bacterial population went down fairly rapidly.

The following figure (Fig. 6) shows the results from a typical laboratory floor with a small number of workers. In the early part of 1939 workmen were still occupied in installing electrical equipment on this floor. The usual increase of

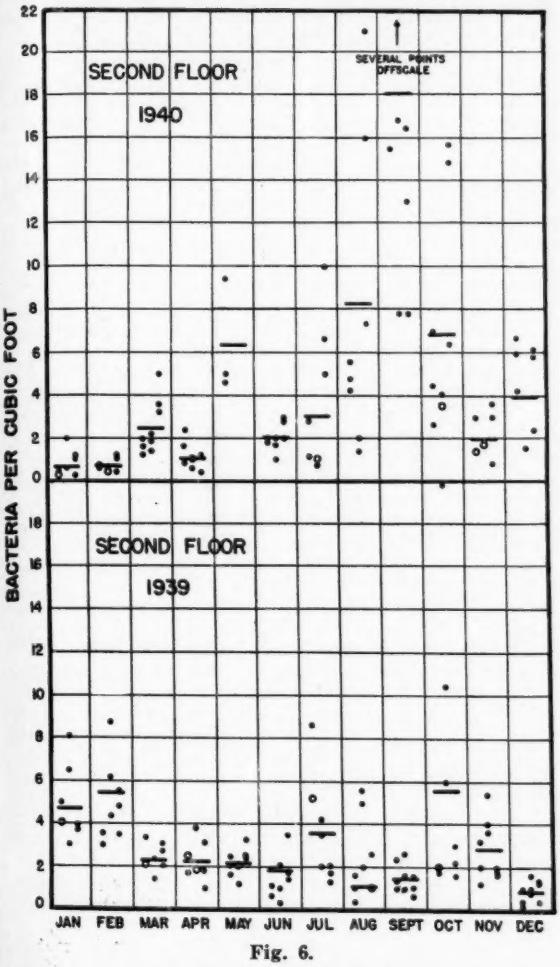

Fig. 6.

bacteria in October and November took place. Very striking again is the tremendous increase of bacterial population in August, September, and October of 1940 caused, as mentioned before, by the keeping of animals close to the air intake of the ventilating system.

The attic of this building is used as a store room. In the early part of 1939 a large amount of old records and laboratory equipment was put into storage on this floor. Beginning in October, 1939, animals were brought to this floor. Beginning with July and August, 1940, a number of sheep and a small supply of hay were also kept on the attic floor. This is probably responsible for the very high bacterial population on this floor.

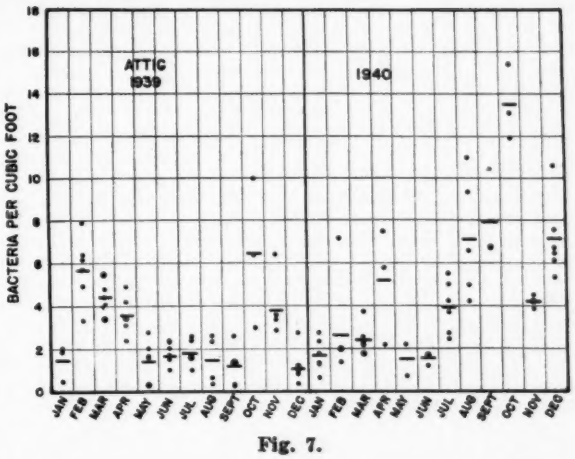

Fig. 7.

A survey was made of the bacterial population in the outside atmosphere. In general, the number of fungous spores found outside was higher than in the building. A record was kept for the times windows were opened in the different rooms. In general, bacterial variation with windows open was not much different than when the windows were closed. One reason for this is that the draft created by open windows helped to keep a large amount of dust in suspension. If there was very much movement in the room occasionally the bacterial population was higher than if only one person was sitting at his desk. It was found that if workmen had their lunch in certain rooms and left scraps around, the bacterial population would increase.

The variation in the two successive years was not very large except as unusual conditions made for increased bacterial population, as for instance, keeping of animals close to the air intake of the ventilating system.

It should be kept in mind that many factors tended to keep the bacterial population to a very low level in the building tested. One is the location of the building away from any population or factory center. The ventilating system may become a source of bacterial contamination by keeping in crevices and corners, dust and bacteria. When the outside atmosphere clears, this might contribute a considerable percentage of the bacterial population in the building. The filter used in this building cannot be a source of bacteria, since no organisms will grow on the bactericidal oil used in the system.

Constitution and By-Laws

—of The American Industrial Hygiene Association—

THE constitutional committee presented to the business meeting of the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION a revised constitution based on the instrument originally drawn up by the founders of the Association but closely adapted to its permanent needs.

This constitution was discussed before the meeting and suggested changes incorporated by the committee. On circulation to the entire membership of the Association, this constitution as given below was adopted on July 15, 1941.

ARTICLE I—NAME

THE name and title of this organization shall be the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION.

ARTICLE II—OBJECT

The object of the Association shall be to increase the knowledge of industrial hygiene through interchange and dissemination of information; to promote the study and control of environmental factors affecting the health and well-being of industrial workers; to correlate such activities as are conducted by individuals and agencies throughout industrial, educational and governmental groups; and to bring together persons interested in the various phases of industrial hygiene.

ARTICLE III—MEMBERSHIP

Section 1. Members shall be persons who are engaged in industrial hygiene activities.

Section 2. Approval by two thirds of the Board of Directors shall be required for election to membership.

ARTICLE IV—OFFICERS

Section 1. The officers of the Association shall be a president, a president-elect, a secretary, and a treasurer. The President-elect, Secretary, and Treasurer shall be elected annually by the members of the Association and shall serve until their successors are elected and installed. The President-elect shall automatically accede to the Presidency on election and installation of his successor.

Section 2. An Executive Secretary may be appointed by the Board of Directors. He need not be a member of the Association and shall hold his office at the pleasure of the Board of Directors.

Section 3. The President shall appoint such committees as are deemed necessary and shall automatically become an ex-officio member of such committees. The personnel of such committees shall be approved by the Board of Directors.

ARTICLE V—ADMINISTRATION

Section 1. The Association shall be governed by the Board of Directors except as otherwise herein expressly provided. They shall delegate to an executive committee authority to administer the affairs of the Association as set forth in the By-Laws.

Section 2. The Board of Directors shall consist of nine elective directors, the four officers, and the two most recent past presidents. The President of the Association shall serve as Chairman of the Board of Directors.

Section 3. Three elective directors shall be elected each year and each shall serve for a term of three years.

Section 4. The Executive Committee shall consist of the four officers of the Association and the two most recent past presidents.

ARTICLE VI—LOCAL GROUPS AND AFFILIATIONS

Section 1. The Board of Directors shall have the power to foster the formation of Local Sections. The Board of Directors shall consider an application from six or more members of the Association to establish a Local Section and the Board of Directors shall establish the geographical area of such sections.

Section 2. The Board of Directors may establish reciprocal relations with any local or national organization whose work and activities are closely allied to industrial hygiene. A group of this nature may become an affiliated society under conditions set up by the Board of Directors.

ARTICLE VII—AMENDMENTS

Amendments to this Constitution may be proposed at any Annual Meeting and must receive a three-fourths affirmative vote of the members present and voting. Proposed amendments must be circulated to the voting membership with a letter ballot. A three-fourths affirmative vote of all ballots returned within thirty days shall be required for adoption.

By-Laws

ARTICLE I—MEETINGS

SECTION 1. The Annual Meeting of the Association shall be held at the time and place selected by the Board of Directors. In making arrangements for meetings, the Board of Directors shall, insofar as is feasible, join or affiliate with organizations that have a common interest. There shall be at least one business session during the Annual Meeting.

Section 2. Notice of all general meetings of the Association shall be sent to the members by the Secretary at least thirty days in advance of the date set for them.

Section 3. Twenty per cent of the members eligible to vote shall constitute a quorum.

Section 4. The Secretary, on direction of the President, shall notify in writing each member of the Board of Directors at least two weeks in advance of a meeting, as to the time, place and purpose of the meeting of the Board of Directors. A majority of the Board of Directors shall constitute a quorum.

ARTICLE II—MEMBERSHIP

Section 1. The Board of Directors may elect to membership in the Association reputable persons who have been engaged in some form of industrial hygiene activity for at least three years and have been graduated from an accredited school of college grade or have had equivalent training. Graduate study may be accepted in place of part or all of the required period of industrial hygiene activity.

Section 2. Application for membership shall be made on a form approved by the Board of Directors. Each applicant must be sponsored by two members in good standing, one of whom resides in the same geographical area as the applicant.

Section 3. The dues shall be $3.00 per year. Dues become payable on the first day of January of each year.

Section 4. Any member whose dues are unpaid on March 1, is not in good standing, and he shall have no vote. When the dues of any member shall not be paid within one year after they are due, his membership is automatically terminated.

Section 5. Any member dropped for non-payment of dues may be reinstated at any time previous to the convening of the Annual Meeting of the year following his delinquency by payment of dues in arrears and also the dues for the current year.

ARTICLE III—ELECTION OF OFFICERS AND DIRECTORS

Section 1. Nominations for officers and elective directors shall be made by a nominating committee of three members to be appointed by the President. Each member of the Nominating Committee shall be from a different Local Section or geographical area. At least sixty days prior to the Annual Meeting the Nominating Committee shall select two nominees for each elective office and shall select five nominees for elective directors. The list of nominations shall be mailed to each member of the Association. The members will vote and return their ballots not later than two weeks prior to the Annual Meeting. In making nominations for elective directors and officers, the Nominating Committee shall give consideration to maintaining on the Board of Directors a balance of representation from industrial, governmental, educational, insurance, and professional interests; and from different geographical areas.

Section 2. Installation of officers and directors shall take place at the last Business Session of the Annual Meeting. Upon expiration of the term of office of the President, he shall become a member of the Board of Directors to serve for two years.

Section 3. The Board of Directors shall have the power to fill vacancies among the officers and directors to serve until the next Annual Meeting of the Association or until their successors are installed.

ARTICLE IV—DUTIES OF OFFICERS

Section 1. The President shall preside at all meetings of the Association and of the Board of Directors and shall perform such other duties as may be directed by the Board of Directors. He should keep in contact with developments in the field of industrial hygiene and guide the Association in the formulation of constructive activities.

Section 2. The Treasurer shall be the custodian of all monies of the Association, shall receive all monies due the Association, and shall pay all authorized bills against the Association. He shall submit his accounts for audit at the meeting of the Board of Directors held during the Annual Meeting and shall transmit to his successor in office all funds and property of the Association in his possession. He shall submit an annual report to the Association in such form as may be determined by the Board of Directors. Should the Treasurer not be able to perform the functions of his office, the Secretary shall assume the functions of that office. The Secretary and Treasurer shall be bonded in such an amount as shall be determined by the Board of Directors from year to year and in a company approved by the Board of Directors. Expense of bond shall be borne by the Association.

Section 3. The Secretary shall keep an accurate record of all the transactions of all meetings of the Association and of the Board of Directors; shall carry on the correspondence of the Association; and shall

keep an accurate list of the members and their status.

ARTICLE V—DUTIES OF THE BOARD OF DIRECTORS AND EXECUTIVE COMMITTEE

Section 1. The Board of Directors shall hold regular meetings at least twice a year, one of these meetings to be held during the Annual Meeting of the Association. They shall review the activities of the Association as presented by the President. They shall consider the qualifications of applicants and elect to membership those applicants who meet the necessary requirements. They shall appoint an editor to edit papers and carry out procedures established by the Editorial Committee.

Section 2. The Executive Committee shall administer the affairs of the Association as delegated by the Board of Directors. Any expenditures to be assessed against the funds of the Association shall be authorized by the Executive Committee prior to their being incurred. The Executive Committee may authorize the President to approve the payment of any regular items of expenditure up to twenty-five dollars. It shall assist the President in carrying out his activities. It shall be responsible to the Board of Directors for its actions.

Section 3. A Local Section council shall be established. Two members shall be elected to this Council by each Local Section of the Association. The President shall call a meeting of this Council during the Annual Meeting and prior to the meeting of the Board of Directors. The Local Section Council shall communicate to the President any desires of the Local Sections. The President shall present the actions of the Local Section Council to the Board of Directors for their consideration.

ARTICLE VI—COMMITTEES

Section 1. The President shall appoint a program committee, consisting of four members. The President-elect shall act as Chairman of the Program Committee and one of the members shall be the Editor or the Chairman of the Editorial Committee. The duty of the Program Committee shall be to provide the program for each meeting of the Association. Satisfactory abstracts of all papers offered for presentation at the Annual Meeting shall be obtained by the Program Committee at least sixty days prior to the date of the meeting.

Section 2. The President shall appoint an ethics committee of three members, one member of which shall be a member of the Board of Directors. Upon recommendation of the Ethics Committee a membership may be terminated by the Board of Directors; provided that a copy of the charge against the member shall be furnished to him in writing at least thirty days before the meeting at which action is taken. A three-fourths vote of all members of the Board of Directors shall be required to terminate membership.

Section 3. All resolutions for submission to the Association shall be referred to the appropriate committee for study and recommendation.

Section 4. The President shall appoint an editorial committee. This Committee shall establish procedures to carry out the editorial policies of the Association and may recommend to the Board of Directors that certain policies be established.

Section 5. The President shall appoint members to serve and to represent the Association on committees formed by other organizations.

Section 6. The President shall appoint a publications committee to devise means and establish procedures for supplying members with copies of published papers, translations, notes from members, and other items which may benefit the members of the Association.

Section 7. The President shall appoint an award committee. This Committee may select a member or group of members of the Association to receive the American Industrial Hygiene Association Award. This Award shall be made in recognition of outstanding service in the field of industrial hygiene and shall be presented not more frequently than once a year.

Section 8. The President shall appoint such other committees as recommended by the Association or the Board of Directors. He shall appoint special committees at his own discretion to facilitate handling the affairs of the Association or its activities.

Section 9. The membership of all committees appointed by the President shall terminate with the close of the Annual Meeting.

ARTICLE VII—LOCAL SECTIONS

Section 1. The officers of each Local Section must be members in good standing of the American Industrial Hygiene Association.

Section 2. The Constitution and By-Laws of each Local Section must be approved by the Board of Directors of the American Industrial Hygiene Association.

ARTICLE VIII—AMENDMENTS

Section 1. Amendments to By-Laws may be proposed at any Annual Meeting by a majority vote of the members present and voting. Proposed amendments shall be circulated to the voting membership with a letter ballot. A majority of letter ballots returned within thirty days shall be required for adoption.

Local Section News

THE MICHIGAN INDUSTRIAL HYGIENE SOCIETY has completed its local section program for the year. This group of meetings promises much of value to those interested in industrial hygiene in the Michigan Section.

6:30 P.M. WEDNESDAY, OCTOBER 29, 1941 DINNER MEETING—L'AIGLON RESTAURANT, DETROIT, MICHIGAN.

"The Toxicity of Wood Dusts. Industrial Health in Woodworking and Allied Industries"—WILLIAM D. MCNALLY, M.D., Professor of Toxicology, University of Illinois, Rush Medical College; Toxicologist for the Coroner, Cook County, Chicago.

8:00 P.M. WEDNESDAY, DECEMBER 3, 1941—HERMAN KIEFER HOSPITAL AUDITORIUM, DETROIT.

"Gas Masks and Respirators."—Motion pictures in color of official testing methods and discussion. H. H. SCHRENK, PH.D., Chief Chemist Health Division, U. S. Bureau of Mines, Pittsburgh.

WEDNESDAY, JANUARY 14, 1942 — LANSING, MICHIGAN.

"Preventive Medicine as related to Industry" — N. W. SCHOLLE, M.D., Assistant Medical Director, Campbell, Wyant & Cannon Foundry Company, Muskegon, Michigan.

"Safety at Work" — C. M. EMERSON, Personnel Manager, Wolverine Brass Works, Grand Rapids, Michigan.

"Syphilis in Industry" — F. J. WEBER, Passed Assistant Surgeon, U. S. Public Health Service, Washington, D. C.

6:30 P. M. WEDNESDAY, FEBRUARY 18, 1942, FISKE BUILDING. DETROIT, MICHIGAN.

"Industrial Dermatitis in Defense Industries" — LOUIS SCHWARTZ, Medical Director, U. S. Public Health Service, Washington, D. C.

FRIDAY, MARCH 27, 1942 — HERMAN KIEFER HOSPITAL AUDITORIUM, DETROIT.

Annual Meeting and All-Day Conference on Industrial Health Conservation.

(Special conference program to be announced)

The foregoing program is tentative. Further information may be obtained from the Society's Secretary.

THE NEW YORK SECTION is to hear DR. L. F. CURTISS, of the National Bureau of Standards, Washington, D. C., discuss "Radium Hazards in Dial Painting." DR. CURTISS is Chairman of the Advisory Committee which recently prepared a handbook covering this subject, published by the National Bureau of Standards. His talk will include a discussion of physical measurements and engineering control.

THE INDUSTRIAL HYGIENE ASSOCIATION OF GREATER ST. LOUIS held its first fall meeting on September 22, 1941. The speakers were THOMAS J. CLIFFORD, Dust Control Engineer, St. Joseph Lead Company, who spoke on "Dust Control in Metal Mines and Mills", and J. W. DAMMERS, Treasurer, G. S. Blakeslee & Company, of Chicago, who presented a talk on "Solvent Degreasing." MR. JOHN BUXELL, formerly Chief Engineer of the St. Louis Industrial Hygiene Service, has recently been appointed by DR. JOSEPH F. BREDECK, Health Com-

missioner, to the position of Sanitary Engineer and Chief of Sanitation of the St. Louis Health Division. MR. BUXELL, however, will still supervise the functions of the St. Louis Industrial Hygiene Service.

THE NEW ENGLAND SECTION is making plans for another of its informative all-day sessions to include papers on recent work conducted in the field of industrial hygiene. Final plans have not yet been completed.

THE CHICAGO SECTION is making plans for a group of six evening dinner meetings to be held during the year. Tentative arrangements have been made for a discussion of "Solvents" by one of the leading authorities connected with a large user of such materials; results of "Recent Investigations of Carbon Disulfide in the Viscose Industry," by DR. MILTON H. KRONENBERG; "Industrial Ventilation," by LESLIE C. STOKES; "Industrial Hygiene Program as Conducted by a Large Industry," by one of the leading industrial hygienists connected with such an industry; a discussion of "Organization of Industrial Hygiene in the National Defense Industries," by an industrial hygienist closely associated with this work; and "Problems and Accomplishments in Industrial Health," by DR. C. O. SAPPINGTON. The first meeting, on October 3, will be addressed by DR. J. A. BRITTON, International Harvester.

A meeting of the officers and executive committee of the Chicago Section convened on September 26 and prepared a constitution and by-laws for presentation to the members of the section.

THE PITTSBURGH SECTION is making plans to hold a meeting on the evening of November 13, 1941, in connection with the Industrial Hygiene Foundation of America. Information will be released shortly concerning the program.

American Industrial Hygiene Association
Officers of Local Sections

Chicago

Chairman ..... CLARK D. BRIDGES, Casualty Mutual Insurance Company, Chicago.

Vice-Chairman.. JAMES R. ALLAN, International Harvester Company, Chicago.

Secy.-Treas. .... WARREN A. COOK, Zurich Insurance Company, Chicago.

Executive Com.: J. D. BERMAN, Western Electric Company, Inc.; Chicago.

PAUL BRAND, Pullman-Standard Car Mfg. Company, Chicago.

JOSEPH H. CHIVERS, M.D., Crane Company, Chicago.

A. J. R. CURTIS, Portland Cement Association, Chicago.

HARVEY G. HENSEL, Youngstown Sheet & Tube Company, Chicago.

A. G. KAMMER, M.D., Inland Sheel Company, Chicago.

MILTON H. KRONENBERG, M.D., Illinois State Dept. of Health, Chicago.

LESLIE M. RICE, Liberty Mutual Insurance Company, Chicago.

LESLIE C. STOKES, Illinois State Dept. of Labor, Chicago.

EUGENE L. WALSH, M.D., International Harvester Company, Chicago.

Detroit

President ..... WILLIAM R. BRADLEY, Department of Health, Detroit.

President-Elect . STUART F. MEEK, M.D., Chrysler Corporation, Detroit.

Past President .. WILLIAM T. KREBS, M.D., Hudson Motor Car Company, Detroit.

Secy.-Treas. .... WILLIAM N. WITHERIDGE, Department of Health, Detroit.

Executive Com: MARY ALTON, R.N., Michigan Department of Health, Lansing, Michigan.

A. L. BROOKS, M.D. General Motors Corporation, Detroit, Michigan.

H. G. DYKTOR, Michigan Department of Health, Lansing, Michigan.

D. P. IRISH, PH.D., Dow Chemical Co., Midland, Michigan.

T. F. MOONEY, Ford Motor Co., Dearborn, Michigan.

A. O. THALACKER, Detroit Rex Products Company, Detroit, Michigan.

New England

Secretary ..... PHILIP DRINKER

New York

Chairman ..... F. A. PATTY, Fidelity & Casualty Company of New York.

Vice-Chairman.. DR. LEONARD J. GOLDWATER, New York University, College of Medicine.

Secy.-Treas. .... WM. J. BURKE, New York State Division of Industrial Hygiene.

Pittsburgh

Chairman ..... DR. H. F. SMYTH, JR., Mellon Institute, Pittsburgh.

Vice-Chairman.. F. S. MALLETTE, Industrial Hygiene Foundation, Pittsburgh.

Secy.-Treas. .... E. C. BARNES, Westinghouse Electric & Manufacturing Co., Pittsburgh.

Counselers ..... T. LYLE HAZLETT, M.D., Westinghouse Electric & Mfg. Co., and W. P. YANT, Mine Safety Appliances Company, Pittsburgh.

St. Louis

Chairman ..... H. A. THIEMANN, Hartford Accident and Indemnity Company, St. Louis.

Vice-Chairman.. JOHN BUXELL, St. Louis Health Division, St. Louis.

Secy.-Treas. .... MISS AGNES RABBITT, Anheuser-Busch, Inc., St. Louis.

—Continued from page 452

sorbed and a number of the exposed women have since died.

The principal effects of radium are destruction of the blood and the formation of bone cancers.

Tellurium is said to resemble selenium in its action on the human body, but definite information is very scanty. Vanadium is sometimes considered to have an irritating effect on the throat and chest but again details are very difficult to obtain.

The following metals are generally considered to be non-poisonous in so far as industrial use is concerned: Tin, aluminum, gold, silver, copper, cobalt, iron, barium, and titanium.

References:

THE bibliography of industrial medicine is already large and is growing rapidly. It is impossible to list all references, but the following are of special value to students interested in the subject:

Occupation Hazards and Diagnostic Signs. *Bulletin No. 582. U.S. Bureau of Labor Statistics.* Superintendent of Documents, Washington, D.C.

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Industrial Toxicology. HAMILTON, ALICE. Harper's Medical Monographs. Harper and Brothers, 1934.

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Mellor's Modern Inorganic Chemistry. PARKES, G. D., and MELLOR, J. W. Longman, Green and Company, 1939.

Manual of Industrial Chemistry (2 vols.) ROGERS, A. D. Van Nostrand Company, 1931.

Chronic Manganese Poisoning in an Ore-Crushing Mill. *Bulletin No. 247. U.S. Public Health Service,* Superintendent of Documents, Washington, D. C.

Industrial Cadmium Poisoning. BULMER, F. M. R.; ROTHWELL, H. E.; and FRANKISH, E. R. *Canadian Journal of Public Health,* Vol. 29, No. 1, pp. 19-26, January 1938.

A study of Chronic Mercurialism in the Hatters' Fur-cutting Industry. *Bulletin No. 234. U. S. Public Health Service,* Superintendent of Documents, Washington, D. C.

Occupation and Health. International Labor Office. Geneva, 1930.

A full list of Government publications pertaining to occupational diseases and industrial hygiene may be obtained by writing to the Superintendent of Public Documents, Washington, D.C.